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The Value of the Trauma Mechanism in the Triage of Severely Injured Elderly

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Abstract

Background: The triage of trauma patients is currently based on the trauma mechanism. However, it is known that elderly patients can sustain severe injuries due to insignificant trauma mechanisms. As such, triage methods might be questionable.

Objective: To evaluate whether current trauma triage criteria are appropriate in severely injured elderly patients.

Methods: To analyze the effect of the trauma mechanism on triage and treatment, consecutive patients ≥ 55 years of age, with an injury severity score > 15, treated from 2002 to 2005 were divided into those who sustained a high-energy trauma (HET) versus a low energy trauma (LET). Pre-hospital and in-hospital data, injury characteristics, and data on mortality and disablement one year postinjury (sickness impact profile) were analyzed for HET and LET groups.

Results: Age, sex and co-morbidity rate were similar in 84 HET patients and 107 LET patients. HET patients (mean ISS 28) received more sophisticated trauma care than LET patients (mean ISS 22), although mortality was similar (38 vs. 34%). Long-term disablement was also similar (median SIP scores 4 vs. 6). Severe head injuries and the Revised Trauma Score were related to mortality. Physical disablement was related to preexisting co-morbidities. No variables were related to psychosocial disablement.

Conclusions: In elderly people a low energy trauma may lead to severe consequences. Not only the trauma mechanism, but also age, co-morbidity, and the likelihood of a brain injury should be leading in the triage and subsequent management of severely injured elderly.

Key Words
Trauma · Elderly · Triage · Outcome

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Introduction

Although the ageing of man may be respected as a major achievement, it constitutes a large burden on medicine. Also in trauma care, the geriatric patient forms a distinct entity that necessitates a variety of adjustments. Previous data from our trauma center showed an expansion of the geriatric trauma population in the last two decades [1]. Many of our elderly patients were severely injured (injury severity score > 15) after only a minor trauma incident. The mortality of patients ≥ 55 years of age was 35% in contrast to a mortality of 20% of patients < 55 years of age. This difference is in accordance with previous studies [2–5] and confirm the belief that geriatric trauma patients necessitate prompt and aggressive management [6–8].

The Advanced Trauma Life Support (ATLS) triage guidelines suggest transfer to a trauma center of patients ≥ 55 years of age with evidence of high-energy impact [9], even though in this age group high incidence rates of severe injuries after only a minor trauma have been reported [10–12]. Additionally, Philips et al. [13] illustrated that the severity of injury and physiologic disturbance in the elderly is often underestimated. Nevertheless, the trauma mechanism [high energy trauma (HET) versus low energy trauma (LET)] is esteemed of overriding importance in the

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ATLS guidelines [9]. As a consequence, specialized emergency facilities like a trauma helicopter, a mobile medical team, and priority treatment according to ATLS principles at the emergency department are applied more frequently to HET patients than to LET patients. However, it is questionable whether such treatment differences are justified in the injured and vulnerable geriatric population. Therefore, we analyzed two groups of severely injured elderly patients, the one group sustained a HET and the second group sustained a LET.

The objective of the study was to analyze whether current trauma triage guidelines are appropriate in severely injured elderly patients. To elucidate this issue the following three questions were addressed: (1) in what way do the pre-hospital, in-hospital, and injury characteristics differ in elderly HET and LET patients? (2) Which differences in short-term and long-term outcomes between elderly HET and LET patients can be identified? (3) Which factors are related to outcomes in elderly severely injured patients?

Materials and Methods

Included in the study were all consecutive trauma patients with an injury severity score (ISS) > 15 and ≥ 55 years of age, who were treated from September 2002 to January 2005 at the University Medical Center Groningen (UMCG), University of Groningen, the Netherlands, a level one trauma center. Patients were identified using the trauma center's trauma registry database containing all primary and secondary admitted trauma patients with positive signs of life on arrival at the trauma center. The collected patient data from the trauma registry database included gender, age, relevant co-morbidities, use of anti-coagulants, time and mechanism of injury, details on the pre-hospital phase, the revised trauma score (RTS), the course at the emergency department (ED), type and severity of injury, treatment, duration of intensive care unit (ICU) stay, complications, mortality, cause of death, total length of hospital stay, Glasgow Outcome Scale (GOS), and discharge destination.

The ISS was based on the 1998 abbreviated injury scale (AIS) scores for each body region [14]. An injury to a body region was considered severe in case of an assigned AIS score ≥ 3 and ''isolated'' in case it was the only region with an assigned AIS score ≥ 3. The GOS quantifies functional outcome ranging from death (GOS 1) to mild or no disability (GOS 5) [15].

The patients were divided into two groups depending on the trauma mechanism: HET or LET. An injury event was considered a HET in case of a high-speed car crash (> 40 mph), motorcycle crash > 20 mph, car-pedestrian or car-bicyclist injury with > 5 mph impact, ejection from car, or fall > 13 feet. An injury event was considered a LET in case of a low-speed crash, a fall < 13 feet, a fall down the stairs, molestation, or other incident with low energy transfer [9]. No burn patients were treated at our trauma center during the study period.

One year post-injury, the Dutch-speaking patients who were still alive and whose addresses were known, were invited to fill out the Dutch version of the sickness impact profile (SIP-136). This questionnaire assesses sickness – or injury related dysfunction of an individual or population [16, 17]. It consists of 136 statements concerning the functional status in seven categories that can be grouped in physical and psychosocial dimensions, and five independent categories (sleep and rest, home management, eating, work, and recreation). In this study the category ''work'' was left out of consideration because of the patients' age. The scores range from 0 (no disability) to 100. The mean SIP-physical norm score of the Dutch population between 55 and 60 years of age is 3.0, and 5.2 for the population over 60 years of age. The mean SIP-psychosocial score of the norm population ≥ 55 years of age is 3.5 [18]. The questionnaire is intended to be completed by the patient, partner, or relative.

Statistical Analysis

Data was expressed as mean ± SD or as median and interquartile range (IQR) in the case of a skewed distribution. Differences between groups were assessed with the Student's *t* test, Mann–Whitney test, or the Chi-square test. The log rank test was used for time-to-event analysis. The following items were analyzed with respect to their possible relation to mortality: demographics, relevant pre-existing co-morbidity (cardiovascular, pulmonary or diabetes) and use of anti-coagulants, HET or LET mechanism, primary or secondary admission, details on pre-hospital management, RTS, time to diagnostics and total time of work-up at the ED, type and severity of injury. For the outcome analysis one year post-injury, all the aforementioned items were analyzed plus: occurrence of surgical procedures, the length of ICU- and hospital admission, duration of intubation, discharge destination, and the GOS at discharge. Multivariate logistic regression analysis was performed with ISS, RTS, and severe head and neck injury as predictor variables and mortality and the SIP scores as outcome variables.

Table 1. Demographics and pre-hospital characteristics.

	High energy trauma N = 84	Low energy trauma N = 107	p value
Age (years)[a]	69 ± 10	71 ± 10	0.250
	N (%)	N (%)	
Gender male	57 (68)	68 (64)	0.535
Type of incident			
Traffic	74 (88)	12 (11)	
Fall ≥ 13 feet	10 (12)	–	
Fall	–	84 (78)	
Same-level	–	40 (48)	
Stairs < 13 feet	–	26 (31)	
Other fall, < 13 feet	–	18 (21)	
Assault	–	4 (4)	
Other	–	7 (7)	
Mobile Medical Team	36 (43)	9 (8)	< 0.001
Transport			
Ambulance	68 (81)	97 (90)	< 0.001
Helicopter	16 (19)	4 (4)	
Private car		6 (6)	

[a] Mean ± SD

For the purpose of the regression the SIP scores were dichotomized into no disability (SIP score < 6) versus mild to severe disability (SIP score ≥ 6) [19]. Differences were considered significant for a two-tailed p value < 0.05. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) version 12.0.1 for Windows.

Results

During the study period 191 patients were eligible for the study. Forty-four percent (N = 84) of the patients were injured in a HET, 56% (N = 107) in a LET. The HET patients suffered from a blunt injury mostly sustained in a traffic incident or due to a fall from height. Most LET patients were injured due to a fall (< 13 feet) or a traffic incident. No significant differences in age or gender existed between the LET and HET groups (Table 1). Relevant co-morbidities and use of anti-coagulants were similar in both groups. Information on pre-existing co-morbidities was not obtained in 11% of the patients.

Pre-hospital Characteristics

HET patients were five times more often attended by the mobile medical team (MMT) (specialized physician and nurse on the scene) and were more often transported to the trauma center by helicopter than LET patients (Table 1). Three-quarters of the HET and LET patients were directly referred from the scene of injury to the trauma center. The pre-hospital time of primary admitted HET and LET patients was similar; approximately 70 min. An equal amount of secondary admitted HET and LET patients was referred to the trauma centre within 24 h post-injury.

Table 2. Revised Trauma Score, duration of work-up, and time to diagnostics of primary admitted HET and LET patients.

	High energy trauma N = 65	Low energy trauma N = 76	p value
Revised Trauma Score[a]	7.7 ± 3.9	10.7 ± 2.5	< 0.001
Duration of work up[a] (h)	2.7 ± 1.7	3.3 ± 1.6	0.056
Chest X-ray N(%)	59 (92)	50 (66)	
Time to[b] (min)	8 (4–18)	13 (6–47)	0.0126
CT head N(%)	46 (71)	60 (79)	
Time to[b] (min)	50 (33–83)	75 (52–120)	0.0522

[a]Mean ± SD
[b]Median (IQR)

Emergency Department

On arrival at the ED, primary admitted HET patients were in a significantly poorer condition than LET patients according to the RTS (Table 2). The work-up in the primary admitted patients of both groups took on average an equal amount of time. Chest X-rays were made 25% more often and on a significant shorter notice in HET patients than in LET patients. No significant difference in the timing of performing ultrasounds of the abdomen was observed. Although strictly no significant difference was observed in the performance of CT-scans of the head, the p value of 0.0522 illustrated a tendency towards a shorter time span before performance of the CT-scan in HET patients compared to LET patients.

Injury Severity

HET patients were more severely injured than LET patients (Table 3) according to the ISS. Additionally, HET patients were more often severely injured to multiple body regions. However, HET patients suffered less often from severe head and neck injuries than LET patients: 74 versus 88%, respectively. Severe *isolated* head and neck injuries were found less often in HET patients than in LET patients: 40 and 77%, respectively (p < 0.001). No relation between the use of anti-coagulants and severe head and neck injuries was found.

Table 3. Injury severity score and injured body regions for HET and LET patients.

	High energy trauma N = 84	Low energy trauma N = 107	p value
Injury Severity Score[a]	28.1 ± 11.2	21.9 ± 5.7	< 0.001
	N (%)	N (%)	
Number of severely injured body regions[b]			< 0.001
N = 1	44 (48)	89 (83)	
N ≥ 2	40 (52)	18 (17)	
Severe injury to[b]			
Head/neck	62 (74)	94 (88)	0.013
Face	4 (5)	4 (4)	0.176
Chest	38 (45)	9 (8)	< 0.001
Abdomen	11 (13)	10 (9)	0.411
Extremities	28 (33)	9 (8)	< 0.001
External	1 (1)	–	0.258

[a]Mean ± SD
[b]Abbreviated Injury Scale ≥ 3

Table 4. Results of logistic regression analysis.

Variable	β	Se	OR
Related to mortality			
Revised Trauma Score per point	–0.381	0.069	0.683
Severe head/neck injury (Abbreviated Injury Scale ≥ 3)	1.433	0.667	4.192
Constant	1.893	0.768	6.638
Related to morbidity one year postinjury: SIP physical (≥ 6)			
Relevant co-morbidity (present versus absent)	1.087	0.475	2.967
Constant	–0.598	0.375	0.550

Correctly predicted: survivors 89%, non-survivors 58%, overall 77%
SIP physical ≥ 6 74%, SIP physical < 6 51%, overall 73%

In-hospital Characteristics

Clinically relevant complications occurred more often in HET patients than in LET patients: 45 versus 30% (p = 0.029). The type and frequency of complications did not differ between the groups: approximately two-thirds of the complications in both groups concerned pulmonary problems, mostly pneumonia. Approximately, 12% of the complications were of cardiovascular origin (i.e. myocardial infarction, heart failure). Multiple organ failure, sepsis, and systemic inflammatory response syndrome only occurred in less than ten patients and were considered statistically irrelevant. More HET than LET patients were admitted to an ICU (74 versus 45%, p < 0.001). The median length of stay at the ICU did not differ significantly: 5 versus 3 days in HET, respectively LET patients. HET patients were more often mechanically ventilated (73 versus 37%, p < 0.001) but the median duration of ventilation did not differ significantly: 6 days in HET patients and 3 days in LET patients. HET patients underwent more frequently a surgical procedure (mostly fracture surgery or a laparotomy and/or thoracotomy) than LET patients: 45% of HET patients versus 30% of LET patients (p = 0.029). In LET patients the most performed procedures were a craniotomy and fracture surgery. In 8% of patients of both groups intracranial pressure monitoring was performed.

Outcome: Mortality

The in-hospital mortality as well as the time to death did not differ significantly: 38 and 34% of respectively HET and LET patients died, with a median time (IQR) to death of 0.8 (0.1–6.3) days and 2.1 (0.4–6.8) days, respectively. Half of the deaths occurred within 24 h after arrival to the hospital. Analysis of mortality per age bracket (55–64, 65–74, 75–84, 85+ years of age) showed no significant differences between both groups. The causes of death were similar: approximately two-thirds of deaths in both groups were caused by cerebral injury. A further important cause of death was respiratory failure (i.e. acute respiratory distress syndrome, pulmonary contusion, edema, pneumonia): in approximately 15–20% of HET and LET-deaths.

The TRISS method was used to identify preventable deaths (probability of survival > 0.50) [20]. It showed that 28 (9 HET and 19 LET patients) of the 55 deaths could be considered unpredicted. Except one HET patient, all unpredicted deaths suffered from a severe head and neck injury that proved fatal in 17 cases, in three cases combined with a pneumonia. The remaining 11 patients (four HET, seven LET) died of complications, mainly from pulmonary origin (mostly pneumonia). Differences between HET and LET were not revealed, because the numbers were too small for statistical analysis.

Logistic regression analysis showed that severe head and neck injury and the RTS were related to mortality (Table 4). All other variables, including the trauma mechanism, were not related to mortality.

Outcome: at Discharge

The median total in-hospital stay of surviving HET patients was more than twice as long as of surviving

Table 5. Outcome characteristics, hospital stay, and discharge destination, in HET and LET patients.

	High energy trauma N = 84	Low energy trauma N = 107	p value
Outcome at discharge	N (%)	N (%)	
Glasgow Outcome Score			
1 Death	32 (38)	36 (34)	0.149
2 Persistent vegetative state	–	–	
3 Severe disability	7 (8)	3 (2)	
4 + 5 Mild/no disability	45 (54)	68 (64)	
Hospital stay survivors (days)[a]	27 (10 to 45)	11 (4–25)	< 0.001
Discharge destination			
Home	19 (37)	27 (38)	0.427
Rehabilitation center	10 (19)	11 (16)	
Nursing home	14 (27)	13 (18)	
Local hospital	9 (17)	20 (28)	
Outcome 1 year post-injury	N = 43	N = 42	
Sickness Impact Profile Score[a]			
Physical score	4 (0–20)	6 (1–12)	0.849
Psychosocial score	4 (1–20)	6 (2–13)	0.986

[a]Median (IQR)

LET patients (Table 5). The GOS at discharge did not differ between HET and LET patients: over half of the survivors of both groups made good recovery (GOS 4 and 5). Additionally, the discharge destinations were similar between HET and LET patients. One third of both groups were discharged home.

Outcome: One-year Post-injury

Five LET patients died after hospital discharge and within one year after injury. Six patients were not in command of the Dutch language or could not be traced. One hundred and twelve patients (50 HET, 62 LET) were included in the follow-up study. The response-rate was 83% in HET patients and 69% in LET patients. Analysis of respondents versus non-respondents showed no significant differences in gender, age, preexisting co-morbidity, ISS, incidence of severe head and neck injury, clinical course, and GOS at discharge.

One year post-injury 49% of the survivors recovered without physical disabilities and 57% without psychosocial disabilities (SIP physical and psychosocial scores < 6). The scores were similar for both trauma mechanisms (Table 4). Logistic regression analysis showed that the presence of relevant preexisting co-morbidities was related to the occurrence of mild to severe physical disability (SIP ≥ 6) (Table 4). No other variables, including the trauma mechanism, were related to physical or psychosocial disablement. Severe head and neck injuries were not related to the functional outcome one year post-injury.

Discussion

Our study discloses valuable insights in the triage, treatment and outcomes of severely injured geriatric patients. Trauma no longer is a disease of the young and with an expanding population at risk, an increasing patient load can be expected in the near future. Besides injury prevention, we plead an age and injury-driven management of the geriatric trauma patient instead of a trauma mechanism-driven management. Elderly patients with a suspected brain injury and/or relevant co-morbidities deserve special medical alertness regardless of the underlying trauma mechanism.

From our results it appeared that severely injured elderly patients who sustained their injuries in a HET were more severely injured and in a poorer condition on arrival to the trauma center compared to elderly patients who were severely injured in a LET. The HET group was managed with all the trimmings from the moment of injury, including the ED. Their medical approach appeared to be different from LET patients, who in the worst case were attended by the family doctor, transported to the hospital by private means, and managed at the ED at a slower pace. This modest approach would perhaps be justified if LET patients had a better outcome compared to HET patients. In contrast, we found similar mortality rates and also similar functional long-term outcomes in the elderly HET and LET patients. These unexpected outcomes cannot be explained by differences in age, gender, or co-morbidities. However, even though analysis of preventable deaths showed a high percentage of unpredicted deaths, at this retrospective stage it is very difficult to state whether a different management could have changed short-term and long-term outcomes for both HET and LET patients. Differences between both groups were mode of transport, the involvement of the MMT, and the duration of diagnostics at the ED. These findings raise the question whether the current triage criteria of ATLS, which are mainly based on the trauma mechanism, should be reconsidered in the elderly injured patient.

The purpose of triage is to identify seriously injured patients and to ensure appropriate allocation of staff and resources. Over-triage and subsequent over-treatment is a concern because of the economic consequences; over-triaged patients wrongly consume valuable resources. However, the price to pay for under-triage can be high as well: major trauma patients transferred to a level one trauma center after first having been transported from the scene to another hospital have an increased risk for mortality and morbidity [21]. This increased risk is partly caused by the prolonged time to definitive care and suboptimal care at the referring hospital. Studies showed under-triage of patients over the age of 55 to be twice that of younger patients [13, 22]. However, the ideal system for dealing with elderly patients in general, and especially after a low energy trauma, has yet to be determined. Ochsner et al. [23] advised a trauma response system mainly based on physiologic and trauma mechanism criteria. Our results reveal that such a trauma response system as well should focus on LET patients with suspected brain injuries.

Outcome results in geriatric patients appear to be debatable. Oreskovich et al. [24] suggested that aggressive care of geriatric patients was futile because of high mortality and the finding that survivors rarely regained pre-injury function. Furthermore, the costs of treating elderly trauma patients are greater than that for their younger counterparts, largely because of an increased length of ICU and in-hospital stay [25].

In contrast, Demetriades et al. [26] demonstrated that the introduction of old age (> 70 years) as an absolute trauma team alert criteria combined with early invasive monitoring, resuscitation and ICU-admission reduced mortality from 54 to 34%. Furthermore, aggressive care in elderly injured patients seems justified as we, among others, showed that survivors do not have an unfavorable long-term survival and functional outcome [27, 28].

Jacobs et al. [29] suggested that advanced patient age itself is not predictive of poor outcomes after trauma. The presence of pre-existing co-morbidities adversely affected outcome, implying that the focus should not be on chronological age but on physiological age. Our study confirms this statement, since long-term physical disablement appeared to be related to co-morbidities.

This study has some limitations. Patients were identified retrospectively from a trauma registry and some data were missing. Of some early-deaths data on co-morbidities and use of anti-coagulants were also missing. However, the minor extent of missing data probably did not significantly affect our results.

Conclusion

In elderly patients not only a high-energy trauma, but also a low energy trauma may lead to considerable mortality and morbidity rates. A high index of suspicion of a severe injury, especially brain injury, is essential in patients ≥ 55 years of age, irrespective of the trauma mechanism. Not only the trauma mechanism, but also age, co-morbidities, and the likelihood of a brain injury should be leading in the triage and subsequent management of the severely injured geriatric patient.

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